Revisit Feldstein-Horioka puzzle: evidence from Malaysia (1960-2015)

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Abstract

This paper revisits the Feldstein-Horioka puzzle – the mother of all puzzles – to uncover whether there exists a long-run relationship between domestic investment and domestic savings for the case of Malaysia. This is a long-standing empirical puzzle in macroeconomics which contradicts economic theory: for open economies, savings should be able to flow to where investment returns are most attractive, and hence there should be no correlation between investment and savings. One plausible reason put forth in the literature as an explanation for the puzzle is the reduction in trade frictions. As trade frictions are reduced, capital becomes more mobile, which in turn would mitigate the Feldstein-Horioka puzzle. Using an ARDL framework, we seek to investigate whether trade openness, as a proxy for reduced trade frictions, can help explain the long-run relationship between savings and investment. Although we discover mixed evidence with regards to the role of trade openness, we find that more importantly, the results tend to indicate the presence of possible structural break. Nevertheless, the results from our paper imply that policymakers can set the savings rate as an intermediate target to affect investment and real income.

Keywords: Feldstein-Horioka puzzle, Malaysia, ARDL

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1.0 Introduction

In an open economy where capital is perfectly mobile, Feldstein & Horioka (1980) argued that domestic savings should be unrelated to domestic investment. However, they also documented the existence of a high degree of correlation between savings and investment from a cross-sectional data of developed OECD countries. This apparent inconsistency, which has come to be known as the "Feldstein-Horioka puzzle" (henceforth, the FH puzzle), has sparked a great deal of interest among academics and policymakers to the extent that it has even been coined as the "mother of all puzzles[3]". In the finance literature, it is also known as the "home country bias puzzle".

Theoretically, savings should flow to the most attractive investment projects around the world if we assume a world with perfect capital mobility. Therefore, there should be no correlation between savings and investment. This should especially be true given that, over the last few decades, the global economy has witnessed substantial financial market deregulation, major abolishment of capital controls, as well as advances in information and communications technology that gave a boost to international financial transactions. However, there is an increasing amount of evidence which suggests that there is a robust correlation between domestic savings and investment across different countries and time periods. Hence, the seemingly puzzling relationship between investment and savings is often interpreted to indicate significant levels of capital immobility, even as countries have undergone significant strides towards greater trade and financial liberalization over the last few decades.

Generally, this is also the path that has been taken by Malaysia. While Malaysia has always held a liberal trade position, current account liberalization took place in 1975 and the financial market saw the liberalization of interest rates in 1978, when commercial banks were freely allowed to set deposit and lending rates freely[4]. However, this market-determined interest rate mechanism was briefly interrupted between 1985 and 1987 in order to mitigate the impact of the economic recession at the time. Similarly, the Asian Financial Crisis also necessitated the implementation of capital controls, as well as a currency peg with the US Dollar, in 1998. These capital controls were gradually reduced and by 2005 the fixed exchange rate was replaced with a 'managed float' exchange rate regime based on a basket of currencies[5].

[3] See Obstfeld & Rogoff, (2000, p. 175)
[4] See Braun & Raddatz (2007).
[5] See Kaplan & Rodrik, (2002); Mitchell & Joseph (2010) for a discussion of capital controls in Malaysia.

The objective of this paper is to investigate what factors can help to explain the investment-savings relationship for the case of Malaysia. The rest of the paper will be structured as follows. The second section will briefly review the relevant literature. The third section will discuss the data and methodology employed in the paper, while the fourth section will present the results. The final section concludes.

2.0 Literature Review

The seminal contribution of Feldstein & Horioka (1980) has sparked a vast amount of literature. In a fairly recent review of the voluminous literature, Apergis & Tsoumas (2009) explain several reasons for the wide interest in the FH puzzle among academics and policymakers. The first reason is due to its relation with current account dynamics, which is a central issue in open economy macroeconomics. The second reason is due to the need to evaluate the degree of capital mobility, which in turn determines the ability of a policymaker to target either domestic savings or domestic capital formation as a policy tool. The third reason is due to a host of other policy-related issues ranging from the necessity of a common currency such as the euro, the role of overseas balances, as well as the impact of taxation and savings.

Overall, Apergis & Tsoumas (2009) observe that there remains to be a strong correlation between savings and investment, although lower than what was previously uncovered in earlier attempts. Furthermore, they also find that the majority of studies are unable to invalidate the capital mobility hypothesis. Within this broad literature, attempts to address the FH puzzle by means of cointegration analysis can be further be categorized into two broad strands (De Vita & Abbott, 2002). The first strand is concerned with measuring the degree of capital mobility by tracking the evolution of the investment-saving relationship over time, and across different exchange rate, and capital control regimes. The second strand of literature has challenged the FH framework by arguing that the correlation between saving and investment is due to alternative macroeconomic factors.

De Vita & Abbott (2002) were one of the earliest to utilize the autoregressive distributed lag (ARDL) bounds framework developed by M. H. Pesaran & Shin, (1999) and M. H. Pesaran, Shin, & Smith (2001) in addressing the question of whether savings and investment rates were cointegrated in the US. Using US quarterly data from 1946 to 2001, they found evidence that the saving-investment correlation weakened significantly under a more liberalized floating exchange rate regime, after the collapse of the Bretton Woods arrangement in 1971. Therefore, they argue that the FH approach helps to provide a partially informative measure of capital mobility.

However, Narayan (2005) finds that the savings-investment correlation for China encompasses both the fixed exchange rate and the entire sample period using annual data over 1952 to 1998, which suggests conformity to the FH hypothesis. Utilizing an ARDL framework, they explain that these results are valid as China has had a fairly restrictive policy with regards to capital mobility throughout the period of interest, and is characterised by relatively low foreign direct investment. Additionally, they develop critical values for the bounds F-test which are suitable for smaller sample sizes. Furthermore, they also utilize tests for endogenous structural breaks using tests developed by Zivot & Andrews (1992) and Lumsdaine & Papell (1997).

Nevertheless, the exogenous treatment of structural breaks is commonly employed in the literature. For example, Ang (2007) utilizes a dummy variable to account for a structural break in the investment series due to the impacts of the Asian Financial Crisis in 1997/1998. Using annual Malaysian data for the period 1965 to 2003, they find sufficient evidence of a robust cointegrating relationship between domestic savings and investment in an ARDL framework. In contrast to the FH hypothesis, they find that the elasticity of the investment with respect to saving to be much lower than predicted. However, they do not attempt to explain what causes investment to be less dependent on savings.

Although many explanations have been put forth for the FH puzzle, Eaton, Kortum, & Neiman (2015) finds that the removal of trade frictions reduces the dependence of domestic investment on domestic saving by half or removes it entirely. This is supported by Ford & Horioka (2016) who argue that frictions in global financial markets and/or global goods markets can impede net transfers of capital between countries. This in turn prevents real interest rates from being equalized across countries, which leads to the FH puzzle.

Therefore, this paper attempts to bring about a small contribution to the vast literature by exploring whether the reduction of trade frictions, as a proxy for increased capital mobility, can help to explain the FH puzzle in the case of Malaysia, and thereby extending Ang's (2007) investigation.

3.0 Data and Methodology

The data for this paper is obtained from the World Bank's World Development Indicators[6]. In particular, we will use data for savings (SAV), investment (INV), real income (RY) and openness (TRA), where the variables SAV, INV, TRA are already expressed as a percentage of GDP. Annual data for Malaysia is available for all the variables of interest from 1960 to 2015[7]. We seek to explore whether changes in the investment-savings relationship are related to changes in the degree of openness, TRA, which we take as a proxy for reduced trade frictions, and how these relationships are related to real income.

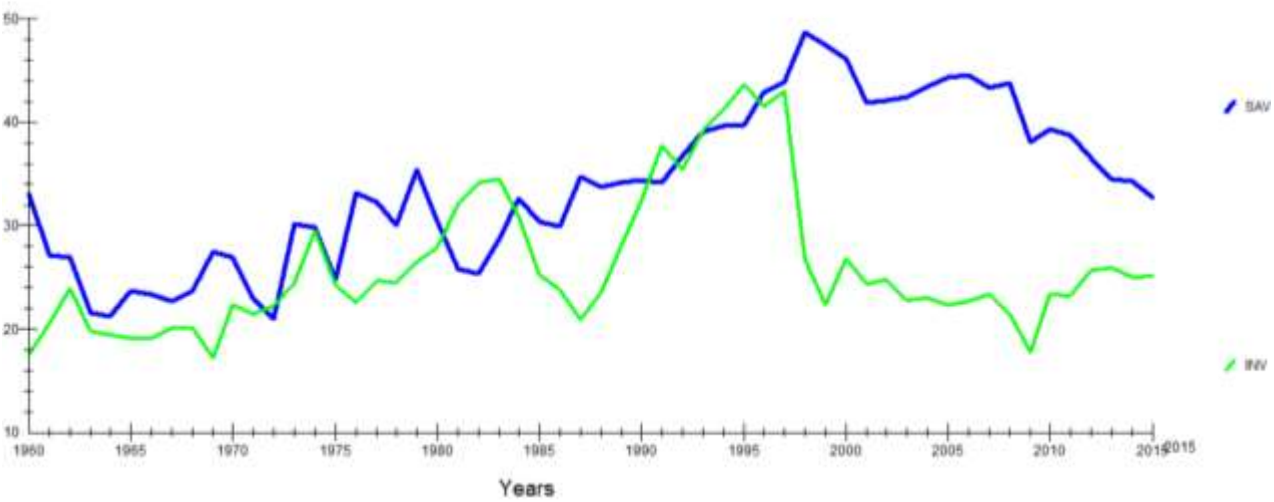

Figure 1: Simple plot of the savings and investment variables

A simple scatter plot of the main variables of interest, SAV and INV, shows a close relationship but which broke down after 1998. Despite the apparent schism that developed thereafter, movements in SAV and INV still appeared to mirror each other until 2008 when SAV started to converge slowly toward INV. Furthermore, given the economic significance of these dates, it should be clear that simple cointegration analysis may be insufficient without accounting for potential structural breaks. Therefore, we construct several dummy variables to test for structural breaks: D1 for the Asian Financial Crisis, D2 for the Global Financial Crisis and D3 to account for fixed exchange rate regimes; whereas D4 and D5 are two sets of dummies to account for capital controls that came into place after the Asian Financial Crisis. D4 covers the period 1998 to 2008, whereas D5 covers 1998 to 2015.

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[6] http://databank.worldbank.org

[7] See Appendix A1 for data description and sources.

The choice of taking logarithmic transformation is non-trivial for variables already in percentage form. Within the investment-savings literature, there are papers like Ang (2007) who log-transforms the investment-to-GDP and savings-to-GDP ratios, but there are others like Narayan (2005) who appear not to do so. Nevertheless, we proceed with logarithmic transformation in order to make the series stationary in its variance[8]. Detailed data descriptions, sources and transformations are provided in the appendix[9].

In order to formally explore the existence of a long-run relationship between investment and savings, we perform standard time series econometrics methodologies: unit root tests and cointegration analysis. If we are sufficiently satisfied that a long-run relationship exists, then we can ascertain the causal direction through error correction modelling.

4.0 Results

4.1 Unit Root Tests

We utilize standard unit root tests to assess the stationarity of the variables: the Augmented Dickey Fuller (ADF) tests and Phillips-Perron (PP) tests. The ADF and PP tests the null hypothesis of a unit root, against the alternative that it is stationarity. While the ADF test adjusts for correlation, the PP test adjusts for both autocorrelation and heteroscedasticity. The results from both ADF and PP tests, shown for the four variables of interest in Table 1a and Table 1b[10] below, imply that the logged transformed variables LINV, LTRA and LRY are integrated of order one, I(1). This indicates the existence of a unit root. For LSAV however, there is a minor conflict as the ADF test implies it is I(1), but the PP test implies it is integrated of order zero, I(0).

Standard unit root tests may bring about misleading conclusions if the presence of structural breaks is not accounted for. B. Pesaran & Pesaran (2009) explains how unit root tests can be applied to a series after controlling for a set of deterministic or exogenous variables. However, even after controlling for various dummies[11], unit root tests still show that the

[8] See Appendix A3 for additional plots of the investment and savings variables in logarithmic and differenced forms.
[9] See Appendix A2 for data transformations.
[10] The results shown in Table 1a and 1b correspond to the highest AIC, but we find that there is no significant qualitative difference when we read off the highest SBC. For ADF tests, we compare against the constant and trend for level variables, and constant for differenced variables.
[11] The results of these additional unit root tests can be found in Appendix B1.

variables are largely integrated of order one I(1), with the exception of LRY which the ADF test finds to be of order I(2). We can only proceed with Engle-Granger or Johansen tests for cointegration if we are sufficiently confident that all the variables are integrated of the same order. While the Engle-Granger method can test for one cointegrating relationship, the Johansen cointegration test allows for more than one cointegrating relationship.

Table 1: Unit Root Tests: ADF, PP & KPSS

Table 1a: ADF Tests

	Level				Differenced				
	Order	T-Stat	CV	Result		Order	T-Stat	CV	Result
LSAV	2	-0.2115	-3.5279	Non-stationary	DLSAV	1	-8.4263	-2.9680	Stationary
LINV	1	-2.2748	-3.5669	Non-stationary	DLINV	1	-4.8554	-2.9680	Stationary
LTRA	1	-0.5135	-3.5669	Non-stationary	DLTRA	1	-4.6878	-2.9680	Stationary
LRY	1	-1.3514	-3.5669	Non-stationary	DRY	1	-5.1036	-2.9680	Stationary

Table 1b: PP Tests

	Level			Differenced			
	T-Stat	CV	Result		T-Stat	CV	Result
LSAV	-3.6507	-3.5486	Stationary	DLSAV	-9.1526	-2.8323	Stationary
LINV	-2.1416	-3.5486	Non-stationary	DLINV	-7.8987	-2.8323	Stationary
LTRA	-1.9354	-3.5486	Non-stationary	DLTRA	-5.6953	-2.8323	Stationary
LRY	-0.7347	-3.5486	Non-stationary	DRY	-6.2507	-2.8323	Stationary

Table 1c: KPSS Tests

	Level			Differenced			
	T-Stat	CV	Result		T-Stat	CV	Result
LSAV	0.1132	0.1551	Stationary	DLSAV	0.1525	0.3957	Stationary
LINV	0.1330	0.1551	Stationary	DLINV	0.2092	0.3957	Stationary
LTRA	0.0998	0.1551	Stationary	DLTRA	0.1487	0.3957	Stationary
LRY	0.1415	0.1551	Stationary	DRY	0.3261	0.3957	Stationary

On the other hand, Kwiatkowski, Phillips, Schmidt, & Shin (1992) argues that the widely used ADF and PP tests have low power of rejecting the null hypothesis, since they are designed on the basis of the null that a series is I(1). Therefore, they develop an alternative, KPSS test, in which the null hypothesis is stationary. The results of the KPSS tests, shown in in Table 1c, suggests that the variables are stationary, or integrated of order zero, I(0). This is in contrast to the broad results obtained from ADF and PP tests, which suggests that the variables are integrated of order one, I(1).

Taken together, we might have sufficient evidence to proceed with either Engle-Granger or Johansen cointegration tests, as the variables appear to be integrated of the same order. However, these tests are subject to asymptotic properties and hence, require a large sample size. This criteria may not be fulfilled with the annual data we are working with, as it covers the period 1960 to 2015 spanning at most 55 observations. Furthermore, due to the conflict between ADF & PP tests with the KPSS test, we cannot be reliably certain that the variables are actually integrated of the same order. Therefore, we proceed with the ARDL test for cointegration which does not require with certainty that the underlying regressors are trend- or first-difference stationary.

4.2 Test for Lag Order Selection

The ARDL econometric specification relies on the assumption that the error term is serially uncorrelated. Therefore, it is important to choose an appropriate lag order *p* that is high enough to remove problems of serial correlation. However, given the relatively small sample size we should avoid over-parameterization and be careful not to include too many lags.

A conditional error correction model (ECM) is estimated by ordinary least squares (OLS), both with and without a deterministic time trend. The optimal lag length is guided by the highest value of the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) as shown in Table 2 below. AIC focuses on a large value of log-likelihood, and hence tends to choose a higher order of lags, whereas SBC is concerned with over-parameterization, and hence tends to choose a lower order of lags.

Table 2: Optimal Lag Selection

Table 2a: Without Deterministic Trend

Order	LL	AIC	SBC		LR Test	Adj LR Test
6	332.67	232.67	138.08		------	------
5	315.81	231.81	152.36	$\chi^2(16)$ =	33.7[.006]	16.5[.418]
4	311.85	243.85	179.53	$\chi^2(32)$ =	41.6[.119]	20.4[.944]
3	300.98	248.98	199.79	$\chi^2(48)$ =	63.4[.068]	31.0[.973]
2	292.52	256.52	222.46	$\chi^2(64)$ =	80.3[.082]	39.3[.994]
1	277.00	**257.00**	**238.08**	$\chi^2(80)$ =	111.3[.012]	54.5[.987]
0	258.18	254.18	250.39	$\chi^2(96)$ =	149.0[.000]	73.0[.961]

Table 2b: With Deterministic Trend

Order	LL	AIC	SBC		LR Test	Adj LR Test
6	338.92	234.92	136.54		------	------
5	319.20	231.20	147.96	$\chi^2(16)$ =	39.4[.001]	18.5[.295]
4	315.99	243.99	175.89	$\chi^2(32)$ =	45.9[.054]	21.5[.920]
3	303.60	247.60	194.63	$\chi^2(48)$ =	70.6[.018]	33.2[.949]
2	295.12	**255.12**	217.28	$\chi^2(64)$ =	87.6[.027]	41.1[.988]
1	278.62	254.62	**231.92**	$\chi^2(80)$ =	120.6[.002]	56.6[.978]
0	260.47	252.47	244.90	$\chi^2(96)$ =	156.9[.000]	73.6[.956]

In the model without a deterministic trend, both AIC and SBC indicate that the highest non-zero lag order is one. However, whereas the AIC indicates that the optimal lag order is two for the model with a deterministic trend, whereas the highest non-zero lag order implied by the

SBC is one. Given the need to address serial correlation, we decide it would be more prudent to opt for a lag order of two[12].

4.3 ARDL Approach to Cointegration

The ARDL bounds testing procedure involves two stages. The first stage involves testing for the existence of a long-run relationship between the variables under investigation. This is done by computing the F-statistic for testing the significance of the lagged levels of the variables in the error correction form of the underlying ARDL model. The calculated F-statistic is a test of the null hypothesis that the coefficients of the level variables are jointly zero, i.e. there exists no long-run relationship between them. The second stage of the analysis is to estimate the coefficients of the long-run relations and make inferences about their values.

The asymptotic distribution of the F-test computed in the first stage is non-standard, regardless of whether the regressors of I(0) or I(1). M. H. Pesaran et al., (2001) provides the asymptotic critical values – an upper and lower bound – for different numbers of regressors (k), distinguishing the different cases whether the underlying ARDL model contains an intercept and/or trend. This provides a band which covers all possible classifications of the variables into I(0) and I(1), or even fractionally integrated. If the computed F-test is above the upper bound, then we have sufficient evidence of cointegration. On the other hand, if the computed F-test is less than the lower bound, then we have insufficient evidence of cointegration. However, if the computed F-test falls in between the upper and lower bounds, then the result is inconclusive. While these asymptotic critical values are reliable for sufficiently large samples, they might not be for smaller samples. To this end, Narayan (2005) provides the critical values for the bounds F-test for sample sizes which range from 30 to 80 observations. The computed F-tests in this subsection will be compared against both sets of critical values.

Overall, we find sufficient evidence of a long-run relationship when DLINV and DLSAV are the dependent variables only with the inclusion of the D4 dummy variable, regardless of whether a deterministic trend is included or not. Such evidence of a long-run relationship rules out the possibility of a spurious relationship. In other words, there is sufficient evidence to suggest that a theoretical relationship exists between investment and

[12] It is curious that the p-value from the adjusted LR test is consistently above 5%. This is even the case for the simplest model which only includes LINV and LSAV. One possible explanation for this is due to the relatively small sample size.

saving with the inclusion of the D4 dummy variable. These results are summarized in Table 3 below:

Table 3: Existence of a long-run relationship

Table 3a: With dummy variable D4, but without deterministic trend

	Computed F-stat	M. H. Pesaran et al. (2001)	Narayan (2005)
F(DLINV / DLSAV, DLTRA, DRY)	4.0581	Cointegration at 5%	Cointegration at 10%
F(DLSAV / DLINV, DLTRA, DRY)	4.3741	Cointegration at 5%	Cointegration at 5%
F(DLTRA / DLINV, DLSAV, DRY)	2.3729	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	0.6392	No cointegration	No cointegration

Pesaran Case III – unrestricted intercept and no trend: 10% (2.45, 3.52); 5% (2.86, 4.01); 1% (3.74, 5.06)
Narayan Case III – unrestricted intercept and no trend: 10% (2.578, 3.710): 5% (3.068, 4.334): 1% (4.244, 5.726)

Table 3b: With dummy variable D4 and deterministic trend

	Computed F-stat	M. H. Pesaran et al. (2001)	Narayan (2005)
F(DLINV / DLSAV, DLTRA, DRY)	3.9474	Cointegration at 5%	Cointegration at 10%
F(DLSAV / DLINV, DLTRA, DRY)	4.5418	Cointegration at 5%	Cointegration at 5%
F(DLTRA / DLINV, DLSAV, DRY)	2.2916	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	0.8599	No cointegration	No cointegration

Pesaran Case III: unrestricted intercept and no trend: 10% (2.45, 3.52); 5% (2.86, 4.01); 1% (3.74, 5.06)
Narayan Case III: unrestricted intercept and no trend: 10% (2.578, 3.710): 5% (3.068, 4.334): 1% (4.244, 5.726)

We also document strong evidence of cointegration when DLINV is the dependent variable with the inclusion of the D5 dummy variable, both with and without a deterministic trend. However, there is only inconclusive evidence of cointegration when DLSAV is the dependent variable with a deterministic trend. This is similar to Ang (2007), who did not find evidence of cointegration when savings is the dependent variable.

Without the inclusion of any dummy variables however, we generally find inconclusive evidence of a long-run relationship when DLINV and DLSAV is the dependent variable, whether a deterministic trend is included or not. One exception for this is when DLINV is the dependent variable without accounting for a deterministic trend with cointegration at the 10% level of significance under Pesaran (2001). With the inclusion of D1 and D2 dummy variables, we find no evidence of cointegration when DLINV is the dependent variable, whether a deterministic trend is included or not. With the inclusion of D1 and D2 dummy variables, we find inconclusive evidence as to whether cointegration exists when DLSAV is the dependent variables, whether a deterministic trend is included or not. Similarly, we also find limited evidence of cointegration when DLINV or DLSAV is the dependent variable with the inclusion of D3 dummy variables, regardless of whether a deterministic trend is included. Although not the focus of our study, we find no evidence of cointegration when DLTRA or DRY is the dependent variable throughout our analyses. These additional results are presented in the appendix[13].

As mentioned earlier, we can only proceed to estimate the second stage of the ARDL procedure if we are satisfied that a long-run relationship between the variables exists. This is only true therefore, for the case when we include the D4 dummy variable – when the dependent variable is either investment or savings – and to a lesser extent, when we include the D5 dummy variable – when the dependent variable is savings. For the sake of brevity, only the estimates of the long-run ARDL model with dummy variable D4, in the cases of both with and without a deterministic trend, are included in table 4 below[14].

Table 4: Long-Run ARDL Model

	Table 4a: With dummy D4, but no deterministic trend				Table 4b: With dummy D4, and deterministic trend			
	LINV	LSAV	LTRA	LRY	LINV	LSAV	LTRA	LRY
LINV		0.011 (0.127)	0.382*** (0.138)	2.056 (2.664)		-0.400*** (0.099)	0.644** (0.310)	0.340*** (0.045)
LSAV	-0.903* (0.483)		1.367*** (0.331)	0.968 (4.438)	-0.805*** (0.243)		1.556*** (0.414)	0.309*** (0.089)
LTRA	0.942*** (0.300)	0.299* (0.177)		0.983 (3.264)	0.426** (0.178)	0.268*** (0.089)		-0.046 (0.065)
LRY	0.082 (0.121)	0.102** (0.043)	-0.042 (0.064)		2.031*** (0.396)	1.459*** (0.282)	-0.986 (0.990)	
INPT	-0.757 (1.835)	-0.834 (0.646)	0.001 (0.802)	16.825*** (7.864)	-45.890*** (13.842)	-32.295*** (6.514)	21.550 (22.423)	22.592*** (0.226)
D4	-0.376*** (0.128)	0.089 (0.088)	0.146 (0.093)	-0.279 (1.312)	-0.273*** (0.068)	-0.0308 (0.048)	0.194* (0.105)	0.049* (0.029)
TREND					-0.121*** (0.035)	-0.082*** (0.017)	0.055 (0.057)	0.057*** (0.001)
χ^2: Serial Correlation	0.574 [0.448]	0.334 [0.563]	1.483 [0.223]	1.117 [0.291]	0.857 [0.354]	2.021 [0.155]	0.878 [0.349]	0.171 [0.679]
χ^2: Functional Form	0.218 [0.641]	4.664 [0.031]	0.038 [0.846]	0.179 [0.672]	0.321 [0.571]	1.925 [0.165]	0.079 [0.779]	0.581 [0.446]
χ^2: Normality	1.440 [0.487]	1.189 [0.552]	1.083 [0.582]	1.524 [0.467]	1.802 [0.406]	0.021 [0.990]	1.334 [0.512]	11.917 [0.003]
χ^2: Heterosked asticty	6.661 [0.010]	7.289 [0.007]	0.000 [0.998]	1.522 [0.217]	7.515 [0.006]	7.823 [0.005]	0.127 [0.722]	2.952 [0.086]

Standard errors in brackets, p-values in parentheses

There are several interesting observations here. Firstly, we note the significance of the LTRA variable when LINV and LSAV are the dependent variables, in both models with and without a deterministic trend. This indicates that the investment-savings relationship does

[13] The results of these additional cointegration tests are summarized in Appendix B2.
[14] The long-run ARDL model computed in this, and most, cases are the same whether based on the AIC or SBC. The estimates of the long-run ARDL model with dummy variable D5, with and without a deterministic trend are shown in Appendix B3.

appear to be positively correlated with the degree of openness in the long run. Secondly, the dummy variable is only significant when LINV is the dependent variable, but not when LSAV is the dependent variable. This implies that the dummy variable affects the long-run relationship through its effect on investment rather than savings. Thirdly, it also appears to be that there is a negative relationship between LSAV and LINV, though this relationship is stronger with the inclusion of a deterministic trend. This result contradicts the common finding of a positive relationship between investment and savings. Finally, there is also a stronger positive correlation between LRY with LINV and LSAV, with the inclusion of a deterministic trend. Nevertheless, caution should be taken in interpreting the results literally given the problems with diagnostic tests shown in the Table 4 above.

4.4 Error Correction Model (ECM)

While the models above establish the existence of a long-run relationship between investment and savings, it does not describe the short-run adjustment that takes place in order to bring about the long-run equilibrium. Instead, this is interpreted from error correction models (ECM). The ECM helps to identify which variable is exogenous (strong) and which is endogenous (weak), whereby the coefficient of ecm(-1) is taken as the speed of adjustment. If the value is zero, then there exists no long-run relationship. If the speed of adjustment value is between -1 and 0, then there exists partial adjustment. A value which is smaller than -1 indicates that the model over adjusts in the current period. A truncated version of the error correction models with the inclusion of the dummy variable D4 is provided in Table 5 below, both for the case without and with a deterministic trend[15].

Table 5: Error Correction Models

	Table 5a: With dummy D4, but no deterministic trend				Table 5b: With dummy D4 and deterministic trend			
	DLINV	DLSAV	DLTRA	DRY	DLINV	DLSAV	DLTRA	DRY
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
ecm(-1)	-0.326*** (0.063)	-0.541*** (0.140)	-0.273*** (0.053)	-0.011 (0.008)	-0.578*** (0.095)	-	-0.266*** (0.054)	-0.467*** (0.097)

Standard errors are in brackets, where *, **, *** represent 10%, 5% and 1% significance, respectively.

For both models with and without a deterministic trend, the coefficient on ecm(-1) is negative and significant when DLTRA is the dependent variable. This suggests that openness is an important, endogenous, part of the adjustment process in the long-run relationship

[15] The fuller version of the error correction models with the inclusion of dummy variable D4 is provided in Appendix B4, for both cases with and without a deterministic trend. Similarly, the error correction models with the inclusion of dummy variable D5 is also provided.

between investment and savings. For the above model with no deterministic trend, real income is an exogenous variable. However, for the model with no deterministic trend, real income becomes part of the endogenous process of the investment-savings relationship.

As expected, investment is an endogenous variable in the long-run relationship, in both models with and without a deterministic trend. Similarly, we find that savings is an endogenous variable in the long-run relationship in the model without a deterministic trend. However, we find that the ECM cannot be estimated when the savings rate is used as the dependent variable. In this case, there are no lagged dependent variables in the ARDL model, and therefore the ECM does not exist. Nevertheless, the value of ecm(-1) for the endogenous variables is less than one, but much larger than zero which suggests a relatively speedy adjustment towards the equilibrium.

4.5 Variance Decomposition (VDC)

Unlike the ECM, which gives information about the absolute endogeneity or exogeneity the variance decomposition (VDC) gives us information about the relative endogeneity or exogeneity of the variables. The VDC decomposes the variance of the forecast error of each variable into proportions attributable to shocks from each variable in the system including its own. The variables that depends most on its own past is the most exogenous. Policymakers will set the exogenous variable as an intermediate target in order to affect the endogenous variable.

There are two types of VDCs: orthogonalized and generalized. Generalized VDCs are more informative for two reasons. Firstly, orthogonalized VDCs are not unique and depend on the particular ordering of the variables in the VAR, whereas generalized VDCs are invariant to the ordering of the variables. Secondly, the orthogonalized VDCs assumes that when a particular variable is shocked, all other variables in the model are switched off, but the generalized VDCs do not make such a restriction. The results from the generalized VDC display the degree of self-dependence in response to shocks, is shown in table 6 below, for both cases with and without a deterministic trend[16]. The variable that is ranked higher is the leading variable, and therefore should be set as the intermediate target by policymakers. We include three time horizons, 1, 4 and 10, to depict the short-term, the medium-term and the long-term impact of shocks, respectively.

[16] The model shown here is with the inclusion of dummy variable D4. See Appendix B5 for the model with the inclusion of a dummy variable D5, for both cases with and without a deterministic trend.

Table 6: Variance Decomposition

Table 6a: With dummy variable D4, but no deterministic trend

	Horizon	DLINV	DLSAV	DLTRA	DRY	Rank
DLINV	1	66.6%	0.5%	6.4%	26.5%	2
DLSAV	1	4.3%	71.5%	19.8%	4.4%	1
DLTRA	1	7.8%	24.1%	64.5%	3.5%	4
DRY	1	25.7%	3.8%	4.7%	65.8%	3
DLINV	4	63.7%	1.2%	7.9%	27.2%	2
DLSAV	4	5.3%	70.8%	19.3%	4.6%	1
DLTRA	4	9.4%	23.6%	63.0%	4.0%	3
DRY	4	23.5%	9.1%	8.9%	58.6%	4
DLINV	10	63.5%	1.6%	7.9%	27.1%	2
DLSAV	10	5.5%	70.5%	19.2%	4.7%	1
DLTRA	10	9.4%	23.7%	63.0%	4.0%	3
DRY	10	23.4%	9.9%	9.0%	57.7%	4

Table 6b: With dummy variable D4 and a deterministic trend

	Horizon	DLINV	DLSAV	DLTRA	DRY	Rank
DLINV	1	65.3%	0.5%	5.9%	28.2%	2
DLSAV	1	4.0%	71.6%	19.9%	4.5%	1
DLTRA	1	7.6%	24.2%	64.5%	3.8%	3
DRY	1	27.2%	3.8%	5.0%	64.0%	4
DLINV	4	62.6%	1.2%	7.5%	28.6%	3
DLSAV	4	5.1%	70.9%	19.3%	4.7%	1
DLTRA	4	9.1%	23.7%	63.1%	4.1%	2
DRY	4	24.9%	9.0%	8.8%	57.4%	4
DLINV	10	62.4%	1.5%	7.6%	28.5%	3
DLSAV	10	5.4%	70.6%	19.2%	4.8%	1
DLTRA	10	9.1%	23.8%	63.0%	4.1%	2
DRY	10	24.8%	9.9%	8.8%	56.5%	4

In both models with and without a deterministic trend, we find that savings is the strongest variable, whereas real income is the weakest variable throughout all time horizons. An exception to this is the short-term impact of a shock on real income in the model without a deterministic trend. Nevertheless, this means that policymakers can set savings rate as the intermediate target to influence real income. Furthermore, we observe that the investment-savings relationship has an effect on openness and real income in the model without a deterministic trend given that both have a higher ranked self-dependence compared to the degree of openness. However, we find it interesting that openness has an intervening effect on investment in the model with a deterministic trend, over the medium-term and long-term horizon. This is also the case when we do not include any dummy variables, and also when we include dummy variable D5 as shown in the appendix. These findings would suggest that openness does play a significant role in the long-run relationship through its effect on investment.

4.6 Impulse Response Function (IRF)

The impulse response function (IRF) displays the impact of a shock of one variable on others, their degree of response and how long it would take to normalize. We expect that if a leading variable is shocked, the response of the weak variables will be significant. From our analysis of the VDC earlier, we have seen that savings is our leading variable. The graphs from the generalized IRF when each of the variables are shocked separately, are shown in the Figure 2 below.

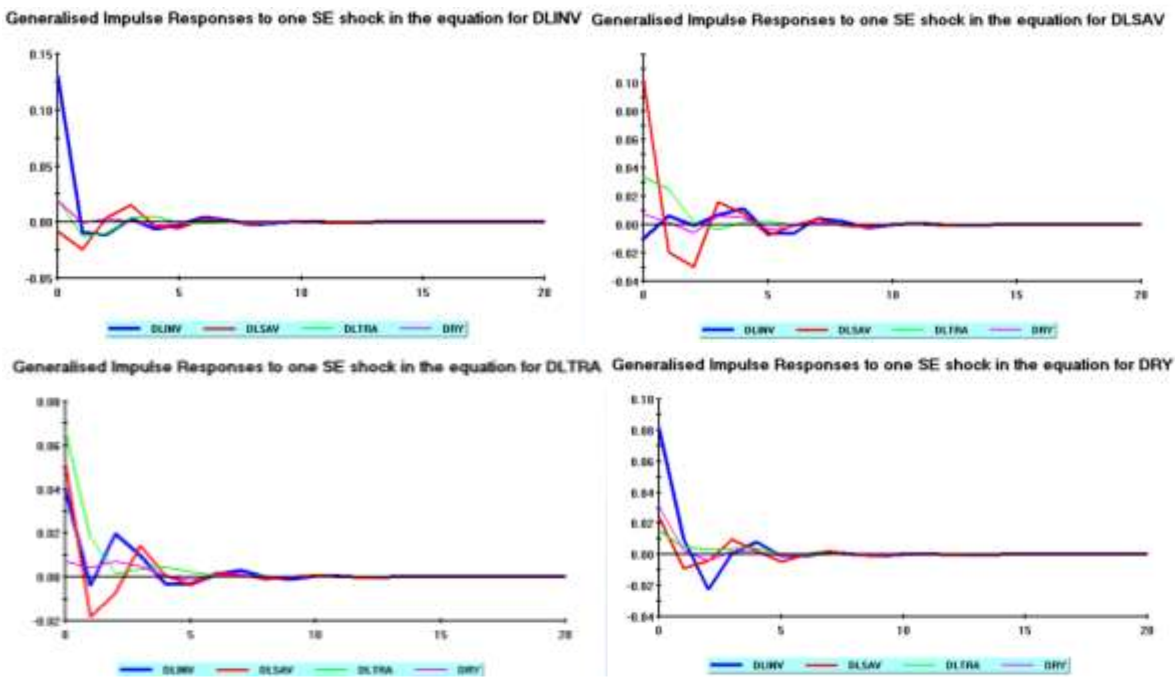

Figure 2: Generalized Impulse Response Function for the models with dummy variable D4, but without a deterministic trend[17]

Consistent with our predictions, we observe that if the savings variable is shocked, the response from the other variables appears to be significant and takes much longer to normalize than when other variables are shocked. However, there are two notable findings from the IRF. Firstly, when the openness variable is shocked, there is a large short-term impact on investment and savings. This supports the idea that openness does have an impact on the investment-savings relationship. Secondly, when the real income variable is shocked, there is a large short-term impact on investment.

[17] The graphs of the generalized IRF in the model without a deterministic trend do not appear to be much different, and are not included here.

4.7 Stability Tests

In this subsection we assess the stability of the coefficients by the cumulative sum (CUSUM) and CUSUM of the squares (CUSUMSQ) tests for the model without and with a deterministic trend. B. Pesaran & Pesaran (2009) explain that the CUSUM test is useful for detecting systematic changes in the regression coefficients, whereas the CUSUMSQ test is useful in situations where the departure from the constancy of the regression coefficients is haphazard and sudden. Plots from the CUSUM and CUSUMSQ test for the model with and without a deterministic trend are given in Figure 3a and 3b below:

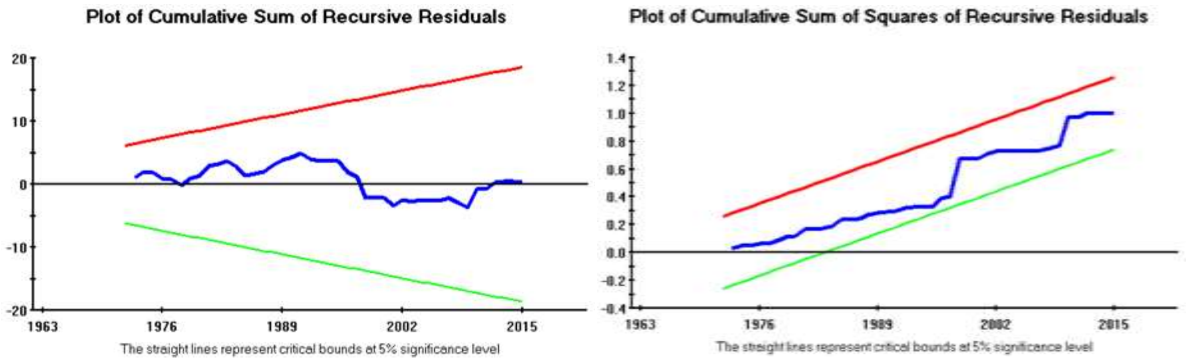

Figure 3a: CUSUM and CUSUMSQ tests for model without a deterministic trend

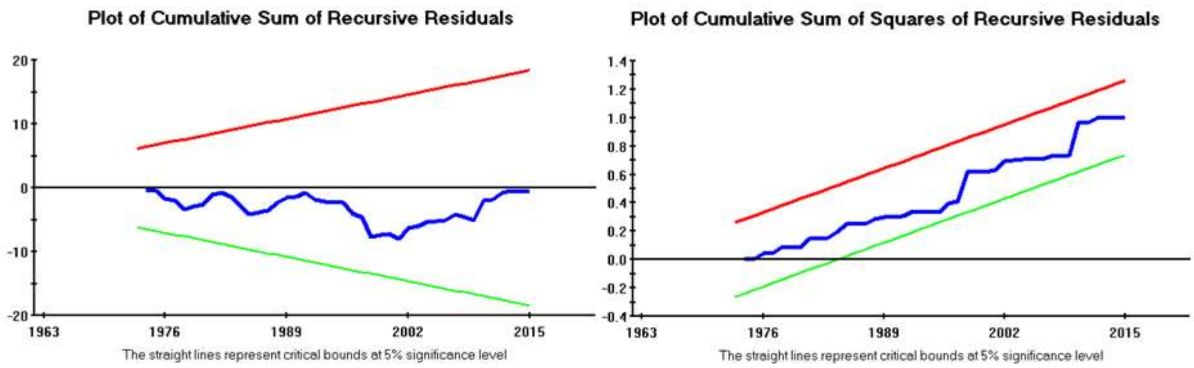

Figure 3b: CUSUM and CUSUMSQ tests for model but with a deterministic trend

In both models with and without a deterministic trend, we observe that neither of the lines are crossed and therefore we cannot reject the null hypothesis that the regression equation is correctly specified at the 5% level of significance. Nevertheless, we can observe that the CUSUM is consistently negative throughout in the model with a deterministic trend. Furthermore, we can also observe sharp turns in the CUSUMSQ in 1998 and 2008, which lend support to the idea that structural breaks should be accounted for.

5.0 Conclusions

We have revisited the ‘mother of all puzzles’ in an attempt to uncover whether there exists a long-run relationship between investment and savings for the case of Malaysia. In particular, we explored the impact of trade openness, as a proxy of reduced trade frictions, on the investment-savings relationship. Our study also explored whether the exogenous treatment of dummy variables to account for structural breaks can help explain or strengthen the investment-savings relationship.

Overall, our main finding is that cointegration can only be identified with the exogenous introduction of a dummy variable after the Asian Financial Crisis. In particular, we find strong evidence of cointegration for the investment-savings relationship with the introduction of a dummy variable which covers the 1998-2008 period. We offer several explanations for this. Firstly, the time period coincides the introduction of capital controls and greater involvement of the central bank with regards to capital flows in the post Asian Financial Crisis period. While some viewed them as necessary to reduce economic fluctuations, these capital control measures may have distorted the investment-savings relationship. Secondly, the introduction of the currency peg with the US dollar in 1998, which was replaced by a managed float exchange rate regime in 2005 based on a basket of currencies. This currency peg may have altered the terms of trade, and affected the investment-savings relationship. Thirdly, the Asian Financial Crisis might have had a permanent negative effect on investor confidence which distorted the investment-saving relationship. This confidence has been somewhat restored in the aftermath of the Global Financial Crisis, and can be seen by the gradual convergence of savings towards investment.

We also find that policymakers can set the savings rate as an intermediate target to affect investment, and ultimately, real income. Nevertheless, the underlying forces that drive the relationship between savings and investment remains unresolved. We find mixed evidence to suggest that trade openness has a significant influence on the investment-savings relationship. Trade openness may not be the best proxy for trade frictions. More generally, better approximations to frictions to global financial markets and global goods market are required in order to have an improved understanding of what drives the investment-savings relationship. We also show that the decision to include a deterministic trend is non-trivial. As the variables are measured as a percentage of GDP, there is no reason why investment and savings should be on an upward trajectory forever.

Although we highlight the importance of accounting for a structural break in this study, we acknowledge that our exogenous treatment of structural breaks may lead to biased conclusions. Further work could utilize endogenous treatment of structural breaks in unit root tests as proposed by Zivot & Andrews (1992) and (Lumsdaine & Papell, 1997). Additionally, further work could also utilize cointegration tests that are appropriate in the presence of a structural break as proposed by Westerlund & Edgerton (2007).

In conclusion, we concede that the FH puzzle remains unresolved. Nevertheless, given the importance of the investment-savings relationship, the results that we gather from this paper should stimulate interest for researchers to pursue the question further.

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Appendix A1: Data Sources

Variable	Code	Indicator Name	Long Definition	Source
INV	NE.GDI.TOTL.ZS	Gross capital formation (% of GDP)	Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.	World Bank national accounts data, and OECD National Accounts data files.
SAV	NY.GDS.TOTL.ZS	Gross domestic savings (% of GDP)	Gross domestic savings are calculated as GDP less final consumption expenditure (total consumption).	World Bank national accounts data, and OECD National Accounts data files.
RY	NY.GDP.MKTP.KN	GDP (constant LCU)	GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant local currency.	World Bank national accounts data, and OECD National Accounts data files.
TRA	NE.TRD.GNFS.ZS	Trade (% of GDP)	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	World Bank national accounts data, and OECD National Accounts data files.

Appendix A2: Data Transformations

Investment	LINV=LOG(INV) DLINV=LINV – LINV(-1)
Savings	LSAV = LOG(SAV) DLSAV = LSAV – LSAV(-1)
Real Income	LRY = LOG(RY) DRY = LRY – LRY(-1)
Openness	LTRA = LOG(TRA) DLTRA = LTRA – LTRA(-1)
Dummy variable for 1997/1998 Asian Financial Crisis	$D1 = \begin{cases} 1, & 1997 - 1998 \\ 0, & \text{otherwise} \end{cases}$
Dummy variable for 2007/2008 Global Financial Crisis	$D2 = \begin{cases} 1, & 2007 - 2008 \\ 0, & \text{otherwise} \end{cases}$
Dummy variable for Fixed Exchange Rate Regime	$D3 = \begin{cases} 1, & 1960 - 1973, 1998 - 2005 \\ 0, & \text{otherwise} \end{cases}$
Dummy variable for 1998 – 2008	$D4 = \begin{cases} 1, & 1998 - 2008 \\ 0, & \text{otherwise} \end{cases}$
Dummy variable for 1998 – 2015	$D5 = \begin{cases} 1, & 2008 - 2015 \\ 0, & \text{otherwise} \end{cases}$

Appendix A3: Additional Plots

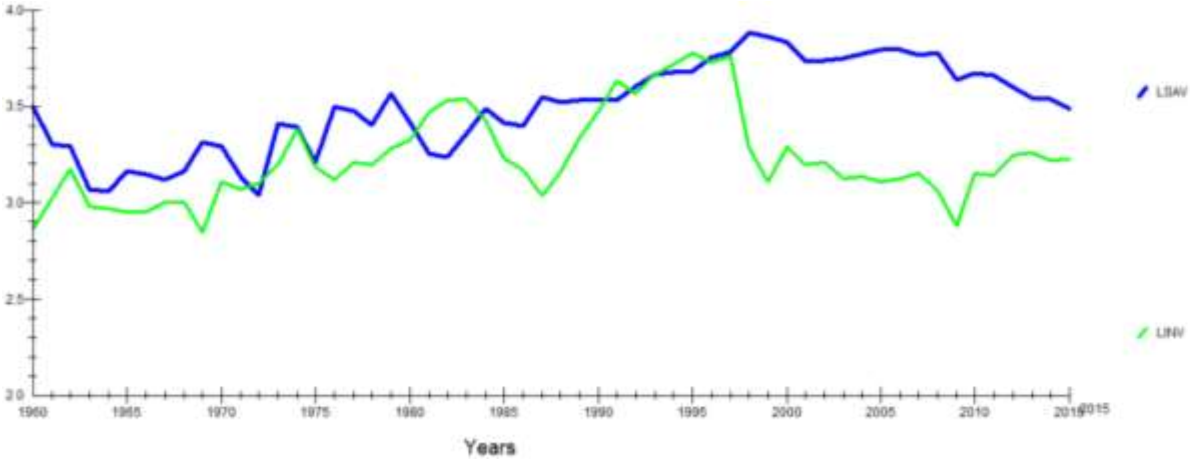

Figure 1a: Logarithmic transformation of savings and investment variable

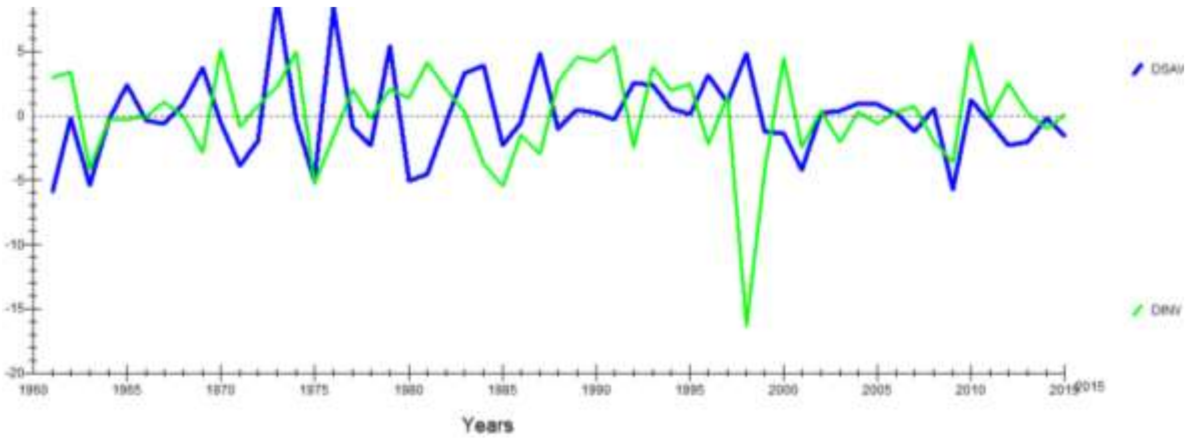

Figure 1b: First difference of savings and investment variables

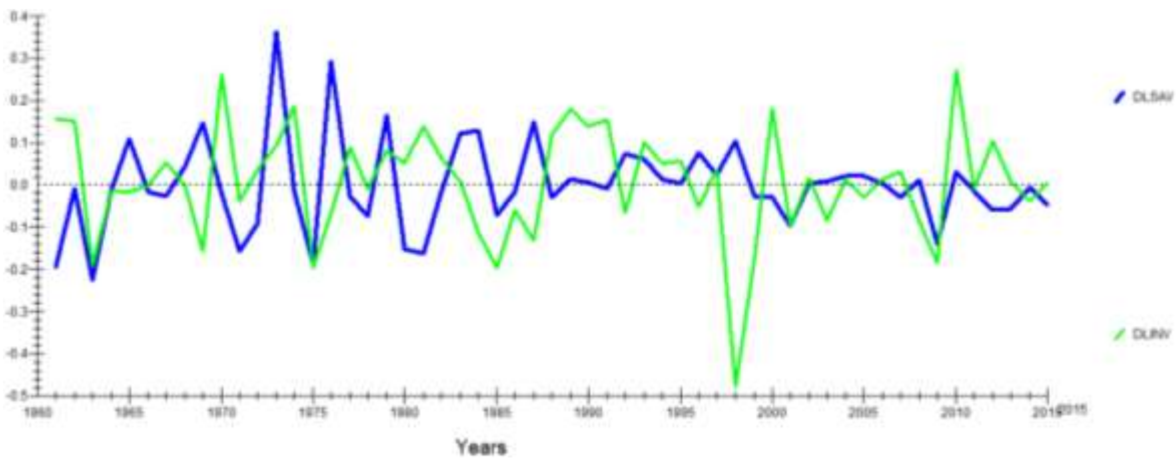

Figure 1c: First difference of log-transformed savings and investment variables

Appendix B1: Additional Unit Root Tests

Table 1d: ADF Tests with dummy variables D1 and D2

	Level				Differenced				
	Order	T-Stat	CV	Result		Order	T-Stat	CV	Result
LSAV	4	-0.3099	-1.8580	Non-stationary	DLSAV	1	-8.6587	-2.2797	Stationary
LINV	4	-0.3497	-1.8580	Non-stationary	DLINV	1	-5.2812	-2.2797	Stationary
LTRA	4	-0.3388	-1.8580	Non-stationary	DLTRA	3	-2.9669	-1.9266	Stationary
LRY	4	-0.2923	-1.8580	Non-stationary	DRY	2	-1.2313	-1.9361	Non-Stationary

Table 1e: PP Tests with dummy variables D1 and D2

	Level				Differenced		
	T-Stat	CV	Result		T-Stat	CV	Result
LSAV	-1.1335	-2.3249	Non-Stationary	DLSAV	-8.6137	-2.8323	Stationary
LINV	-0.9892	-2.3249	Non-stationary	DLINV	-8.2921	-2.8323	Stationary
LTRA	-1.1152	-2.3249	Non-stationary	DLTRA	-5.6787	-2.8323	Stationary
LRY	-1.0171	-2.3249	Non-stationary	DRY	-2.4747	-2.8323	Stationary

Table 1f: ADF Tests with dummy variable D3

	Level				Differenced				
	Order	T-Stat	CV	Result		Order	T-Stat	CV	Result
LSAV	1	-0.6181	-2.2236	Non-stationary	DLSAV	1	-8.2500	-2.2349	Stationary
LINV	1	-0.7420	-2.2236	Non-stationary	DLINV	1	-4.9902	-2.2349	Stationary
LTRA	1	-0.6631	-2.2236	Non-stationary	DLTRA	1	-4.6067	-2.2349	Stationary
LRY	1	-0.6146	-2.2236	Non-stationary	DRY	2	-1.3738	-2.2204	Non-Stationary

Table 1g: PP Tests with dummy variable D3

	Level				Differenced		
	T-Stat	CV	Result		T-Stat	CV	Result
LSAV	-0.6823	-2.1845	Non-Stationary	DLSAV	-8.4658	-2.1683	Stationary
LINV	-0.6482	-2.1845	Non-stationary	DLINV	-7.4863	-2.1683	Stationary
LTRA	-0.6911	-2.1845	Non-stationary	DLTRA	-5.5015	-2.1683	Stationary
LRY	-0.6348	-2.1845	Non-stationary	DRY	-2.8021	-2.1683	Stationary

Table 1h: ADF Tests with dummy variable D4

	Level				Differenced				
	Order	T-Stat	CV	Result		Order	T-Stat	CV	Result
LSAV	1	-0.7912	-2..4420	Non-stationary	DLSAV	1	-8.3759	-2.3886	Stationary
LINV	1	-0.7772	-2.2331	Non-stationary	DLINV	1	-4.9797	-2.3886	Stationary
LTRA	1	-0.7913	-2.4420	Non-stationary	DLTRA	1	-4.6388	-2.3886	Stationary
LRY	1	-0.7403	-2.4420	Non-stationary	DRY	2	-1.3176	-2.2859	Non-Stationary

Table 1i: PP Tests with dummy variable D4

	Level				Differenced		
	T-Stat	CV	Result		T-Stat	CV	Result
LSAV	-0.8553	-2.3240	Non-Stationary	DLSAV	-8.4764	-2.3921	Stationary
LINV	-0.7371	-2.3240	Non-stationary	DLINV	-7.4930	-2.3921	Stationary
LTRA	-0.8418	-2.3240	Non-stationary	DLTRA	-5.4610	-2.3921	Stationary
LRY	-0.7284	-2.3240	Non-stationary	DRY	-2.7650	-2.3921	Stationary

Table 1j: ADF Test with dummy variable D5

	Level				Differenced				
	Order	T-Stat	CV	Result		Order	T-Stat	CV	Result
LSAV	1	-1.1403	-2.7730	Non-stationary	DLSAV	1	-8.6055	-2.6867	Stationary
LINV	1	-1.1258	-2.7730	Non-stationary	DLINV	1	-4.8870	-2.6867	Stationary
LTRA	1	-1.1618	-2.7730	Non-stationary	DLTRA	1	-4.8624	-2.6867	Stationary
LRY	1	-1.1778	-2.7730	Non-stationary	DRY	2	-1.5065	-2.6952	Non-Stationary

Table 1k: PP Tests with dummy variables D5

	Level				Differenced		
	T-Stat	CV	Result		T-Stat	CV	Result
LSAV	-1.2431	-2.6507	Non-Stationary	DLSAV	-8.5715	-2.6495	Stationary
LINV	-1.0899	-2.6507	Non-stationary	DLINV	-7.3218	-2.6495	Stationary
LTRA	-1,2172	-2.6507	Non-stationary	DLTRA	-5.5993	-2.6495	Stationary
LRY	-1.1556	-2.6507	Non-stationary	DRY	-2.9409	-2.6495	Stationary

Appendix B2: Additional Tests for Existence of Long Run Relationship

	Computed F-stat	M. H. Pesaran et al. (2001)	Narayan (2005)
Table 3c: Without dummy variables or deterministic trend			
F(DLINV / DLSAV, DLTRA, DRY)	3.5238	Cointegration at 10%	Inconclusive at 5%
F(DLSAV / DLINV, DLTRA, DRY)	2.8492	Inconclusive at 10%	Inconclusive at 10%
F(DLTRA / DLINV, DLSAV, DRY)	2.0695	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	1.0395	No cointegration	No cointegration
Table 3d: Without dummy variables but with deterministic trend			
F(DLINV / DLSAV, DLTRA, DRY)	3.4444	Inconclusive at 10%	Inconclusive at 10%
F(DLSAV / DLINV, DLTRA, DRY)	3.6859	Inconclusive at 5%	Inconclusive at 10%
F(DLTRA / DLINV, DLSAV, DRY)	2.2515	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	1.1885	No cointegration	No cointegration
Table 3d: With dummy variables D1 and D2, but without deterministic trend			
F(DLINV / DLSAV, DLTRA, DRY)	2.1093	No cointegration	No cointegration
F(DLSAV / DLINV, DLTRA, DRY)	2.9383	Inconclusive at 5%	Inconclusive at 10%
F(DLTRA / DLINV, DLSAV, DRY)	1.7359	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	0.4103	No cointegration	No cointegration
Table 3e: With dummy variables D1 and D2, and with deterministic trend			
F(DLINV / DLSAV, DLTRA, DRY)	1.9571	No cointegration	No cointegration
F(DLSAV / DLINV, DLTRA, DRY)	3.4860	Inconclusive at 5%	Inconclusive at 10%
F(DLTRA / DLINV, DLSAV, DRY)	1.9184	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	0.6885	No cointegration	No cointegration
Table 3f: With dummy variable D3, but without deterministic trend			
F(DLINV / DLSAV, DLTRA, DRY)	3.2329	Inconclusive at 5%	Inconclusive at 5%
F(DLSAV / DLINV, DLTRA, DRY)	2.7213	Inconclusive at 5%	Inconclusive at 10%
F(DLTRA / DLINV, DLSAV, DRY)	1.7275	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	1.2914	No cointegration	No cointegration
Table 3g: With dummy variable D3, and with deterministic trend			
F(DLINV / DLSAV, DLTRA, DRY)	3.0377	Inconclusive at 10%	No cointegration
F(DLSAV / DLINV, DLTRA, DRY)	3.4310	Inconclusive at 10%	Inconclusive at 10%
F(DLTRA / DLINV, DLSAV, DRY)	1.8548	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	1.1103	No cointegration	No cointegration
Table 3h: With dummy variable D5, but without deterministic trend			
F(DLINV / DLSAV, DLTRA, DRY)	7.7775	Cointegration at 1%	Cointegration at 1%
F(DLSAV / DLINV, DLTRA, DRY)	2.3894	No cointegration	No cointegration
F(DLTRA / DLINV, DLSAV, DRY)	1.9240	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	2.2972	No cointegration	No cointegration
Table 3i: With dummy variable D5, and with deterministic trend			
F(DLINV / DLSAV, DLTRA, DRY)	6.9543	Cointegration at 1%	Cointegration at 1%
F(DLSAV / DLINV, DLTRA, DRY)	2.6872	Inconclusive at 10%	Inconclusive at 10%
F(DLTRA / DLINV, DLSAV, DRY)	1.4663	No cointegration	No cointegration
F(DRY / DLINV, DLSAV, DLTRA)	2.4773	No cointegration	No cointegration

Pesaran Case III: unrestricted intercept and no trend: 10% (2.45, 3.52); 5% (2.86, 4.01); 1% (3.74, 5.06)
Narayan Case III: unrestricted intercept and no trend: 10% (2.578, 3.710): 5% (3.068, 4.334): 1% (4.244, 5.726)
Pesaran Case V: unrestricted intercept and unrestricted trend: 10% (3.03, 4.06); 5% (3.47, 4.57); 1% (4.40, 5.72)
Narayan Case V: unrestricted intercept and unrestricted trend: 10% (3.210, 4.294): 5% (3.794, 4.986); 1% (5.108, 6.494)

Appendix B3: Additional Estimated Long Run Coefficients using ARDL Approach

	Table 4c: Without dummy variables or deterministic trend				Table 4d: Without dummy variables, but with deterministic trend			
	LINV	LSAV	LTRA	LRY	LINV	LSAV	LTRA	LRY
LINV		-0.072 (0.112)	0.341** (0.154)	2.441 (2.251)		-0.356*** (0.072)	0.431 (0.326)	0.299*** (0.050)
LSAV	-0.485 (0.883)		1.765*** (0.307)	0.920 (4.679)	-1.312*** (0.376)		1.912*** (0.504)	0.317** (0.130)
LTRA	0.039 (0.541)	0.443*** (0.151)		0.650 (3.005)	0.223 (0.245)	0.235*** (0.072)		0.044 (0.082)
LRY	0.214 (0.121)	0.086** (0.039)	-0.091 (0.072)		2.211*** (0.596)	1.389*** (0.258)	-0.529 (1.120)	
INPT	-1.719 (1.835)	-0.779 (0.647)	-0.164 (0.962)	17.654*** (7.654)	-47.95*** (13.842)	-30.6*** (5.904)	10.008 (25.089)	22.35*** (0.263)
TREND					-0.121*** (0.035)	-0.08*** (0.015)	0.025 (0.064)	0.056*** (0.001)
χ^2: Serial Correlation	0.824 [0.364]	0.420 [0.517]	1.092 [0.296]	1.174 [0.279]	0.201 [0.654]	2.415 [0.120]	0.911 [0.340]	0.694 [0.405]
χ^2: Functional Form	5.454 [0.020]	2.343 [0.126]	0.264 [0.607]	0.221 [0.638]	4.907 [0.027]	2.290 [0.130]	0.712 [0.399]	1.672 [0.196]
χ^2: Normality	9.614 [0.008]	0.933 [0.627]	0.958 [0.619]	1.539 [0.463]	13.084 [0.001]	0.083 [0.959]*	1.027 [0.598]	9.941 [0.007]
χ^2: Heteroskedasticity	5.372 [0.020]	6.490 [0.011]	0.031 [0.861]	1.581 [0.209]	8.146 [0.004]	7.653 [0.006]	0.003 [0.957]	1.755 [0.185]

Standard errors are in brackets, where *, **, *** represent 10%, 5% and 1% significance, respectively. P-values in parentheses.

	Table 4e: With dummy variable D5, but no deterministic trend				Table 4f: With dummy variable D5 and deterministic trend			
	LINV	LSAV	LTRA	LRY	LINV	LSAV	LTRA	LRY
LINV		-0.151 (0.164)	0.465** (0.200)	0.303 (7.846)		-0.399*** (0.091)	0.548 (0.328)	0.226*** (0.078)
LSAV	-0.939** (0.369)		1.619*** (0.295)	3.467 (13.344)	-0.958*** (0.279)		1.730*** (0.465)	0.290** (0.138)
LTRA	0.621*** (0.213)	0.476*** (0.130)		6.552 (23.261)	0.347* (0.192)	0.266*** (0.083)		0.099 (0.099)
LRY	0.266*** (0.066)	0.108** (0.053)	-0.133 (0.080)		1.516*** (0.541)	1.358*** (0.263)	-0.465 (1.008)	
INPT	-3.654*** (1.189)	-1.268 (1.004)	1.219 (1.363)	0.966 (47.677)	-32.639*** (12.436)	-29.829*** (6.005)	8.669 (22.598)	22.414*** (0.275)
D5	-0.442*** (0.111)	-0.804 (0.124)	0.168 (0.157)	-7.979 (27.608)	-0.303*** (0.107)	-0.0479 (0.0616)	0.168 (0.163)	-0.072 (0.066)
TREND					-0.077** (0.033)	-0.075*** (0.016)	0.019 (0.058)	0.057*** (0.002)
χ^2: serial correlation	0.027 [0.869]	0.470 [0.493]	1.661 [0.198]	0.349 [0.555]	0.062 [0.803]	1.954 [0.162]	1.408 [0.235]	0.103 [0.749]
χ^2: functional form	0.736 [0.391]	1.900 [0.168]	0.052 [0.819]	0.483 [0.487]	1.210 [0.271]	1.751 [0.186]	0.272 [0.602]	0.598 [0.439]
χ^2: Normality	3.465 [0.177]	0.983 [0.612]	1.085 [0.581]	1.397 [0.497]	9.974 [0.007]	0.082 [0.960]	1.114 [0.573]	4.444 [0.108]
χ^2: Heteroskedasticity	7.164 [0.007]	6.111 [0.013]	0.017 [0.895]	0.522 [0.470]	8.387 [0.004]	7.912 [0.005]	0.050 [0.823]	2.164 [0.141]

Standard errors are in brackets, where *, **, *** represent 10%, 5% and 1% significance, respectively. P-values in parentheses.

Appendix B4: Additional ECM

	Table 5c: with dummy variable D4 and no deterministic trend				Table 5d: with dummy variable D4 and a deterministic trend			
	DLINV	DLSAV	DLTRA	DRY	DLINV	DLSAV	DLTRA	DRY
DLINV		-0.334**	0.275***	0.196***			0.312***	0.220***
		(0.126)	(0.072)	(0.032)			(0.081)	(0.029)
DLINV1								-0.036
								(0.024)
DLSAV	-0.294**		0.373***	0.139***	-0.465***		0.414***	0.144***
	(0.139)		(0.064)	(0.044)	(0.136)		(0.076)	(0.039)
DLTRA	0.852***	0.954***		-0.125	0.794***			-0.139**
	(0.216)	(0.188)		(0.073)	(0.196)			(0.064)
DLTRA1		-0.336*	0.144				0.135	
		(0.178)	(0.099)				(0.099)	
DRY	2.110***	1.351***	-0.454*		2.501***		-0.620*	
	(0.353)	(0.424)	(0.265)		(0.341)		(0.312)	
DRY1	0.760**				0.607*			
	(0.350)				(0.320)			
DD4	-0.123**	-0.048	0.040	-0.003	-0.158***		0.052	-0.023
	(0.048)	(0.047)	(0.029)	(0.015)	(0.045)		(0.032)	(0.014)
DTREND					-0.068***		0.015	0.027***
					(0.020)		(0.015)	(0.006)
ecm(-1)	-0.326***	-0.541***	-0.273***	-0.011	-0.578***		-0.266***	-0.467***
	(0.063)	(0.140)	(0.053)	(0.008)	(0.095)		(0.054)	(0.097)

Standard errors are in brackets, where *, **, *** represent 10%, 5% and 1% significance, respectively.

	Table 5e: with dummy variable D5 and no deterministic trend				Table 5f: with dummy variable D5 and a deterministic trend			
	DLINV	DLSAV	DLTRA	DRY	DLINV	DLSAV	DLTRA	DRY
DLINV		-0.416***	0.274***	0.172***			0.283***	0.171***
		(0.123)	(0.075)	(0.035)			(0.080)	(0.031)
DLSAV	-0.391***		0.410***	0.116***	-0.514***		0.426***	0.154***
	(0.131)		(0.060)	(0.042)	(0.143)		(0.078)	(0.040)
DLTRA	0.781***	1.037***		-0.096	0.748***			-0.093
	(0.214)	(0.177)		(0.071)	(0.209)			(0.064)
DLTRA1		-0.353*	0.162				0.159	
		(0.180)	(0.100)				(0.102)	
DRY	1.901***	1.304***	-0.430		2.256***		-0.487*	
	(0.348)	(0.439)	(0.272)		(0.410)		(0.321)	
DRY1	0.673*				0.590*			
	(0.348)				(0.341)			
DD5	-0.184***	-0.044	0.043	-0.028	-0.163**		0.041	-0.023
	(0.067)	(0.069)	(0.043)	(0.021)	(0.066)		(0.044)	(0.019)
DTREND					-0.041***		0.005	0.019***
					(0.021)		(0.014)	(0.006)
ecm(-1)	-0.416***	-0.549***	-0.253***	-0.004	-0.537***		-0.247***	-0.326***
	(0.082)	(0.142)	(0.049)	(0.010)	(0.101)		(0.054)	(0.097)

Standard errors are in brackets, where *, **, *** represent 10%, 5% and 1% significance, respectively.

Appendix B5: Additional VDC

Table 6c: No dummy variables or deterministic trend

	Horizon	DLINV	DLSAV	DLTRA	DRY	Rank
DLINV	1	64.7%	0.4%	5.9%	29.0%	3
DLSAV	1	4.4%	71.4%	19.6%	4.5%	1
DLTRA	1	8.1%	23.2%	64.9%	3.8%	2
DRY	1	27.5%	3.7%	4.8%	64.0%	4
DLINV	4	62.8%	1.1%	6.9%	29.2%	3
DLSAV	4	5.7%	70.2%	19.3%	4.8%	1
DLTRA	4	9.9%	22.6%	63.3%	4.3%	2
DRY	4	26.2%	8.5%	8.1%	57.2%	4
DLINV	10	62.7%	1.3%	6.9%	29.1%	3
DLSAV	10	5.9%	69.9%	19.3%	4.9%	1
DLTRA	10	9.9%	22.6%	63.2%	4.3%	2
DRY	10	26.2%	9.1%	8.2%	56.6%	4

Table 6d: No dummy variables, but with deterministic trend

	Horizon	DLINV	DLSAV	DLTRA	DRY	Rank
DLINV	1	64.8%	0.5%	5.9%	28.8%	3
DLSAV	1	4.8%	71.1%	19.6%	4.4%	1
DLTRA	1	8.3%	22.9%	65.2%	3.6%	2
DRY	1	28.1%	3.3%	4.4%	64.3%	4
DLINV	4	62.7%	1.2%	6.7%	29.4%	3
DLSAV	4	5.9%	70.1%	19.2%	4.8%	1
DLTRA	4	10.2%	22.5%	63.6%	3.8%	2
DRY	4	26.2%	8.8%	6.9%	58.0%	4
DLINV	10	62.5%	1.5%	6.7%	29.3%	3
DLSAV	10	6.1%	69.7%	19.2%	4.9%	1
DLTRA	10	10.2%	22.5%	63.5%	3.8%	2
DRY	10	26.1%	9.7%	7.1%	57.1%	4

Table 6e: With dummy variable D5, but no deterministic trend

	Horizon	DLINV	DLSAV	DLTRA	DRY	Rank
DLINV	1	65%	1%	6%	28%	4
DLSAV	1	5%	71%	20%	4%	1
DLTRA	1	8%	23%	66%	3%	2
DRY	1	28%	2%	4%	66%	3
DLINV	4	63%	1%	7%	29%	3
DLSAV	4	6%	71%	19%	4%	1
DLTRA	4	10%	23%	64%	3%	2
DRY	4	26%	9%	5%	60%	4
DLINV	10	62%	1%	7%	29%	3
DLSAV	10	6%	70%	19%	5%	1
DLTRA	10	10%	23%	64%	3%	2
DRY	10	26%	10%	6%	59%	4

Table 6f: With dummy variable D5 and deterministic trend

	Horizon	DLINV	DLSAV	DLTRA	DRY	Rank
DLINV	1	66%	1%	5%	28%	3
DLSAV	1	6%	71%	19%	4%	1
DLTRA	1	9%	21%	67%	2%	2
DRY	1	28%	2%	2%	67%	4
DLINV	4	64%	2%	6%	29%	3
DLSAV	4	7%	69%	19%	4%	1
DLTRA	4	12%	21%	65%	3%	2
DRY	4	26%	9%	4%	62%	4
DLINV	10	64%	2%	6%	29%	3
DLSAV	10	8%	69%	19%	5%	1
DLTRA	10	12%	21%	65%	3%	2
DRY	10	26%	10%	4%	61%	4

Appendix B6: Additional IRF

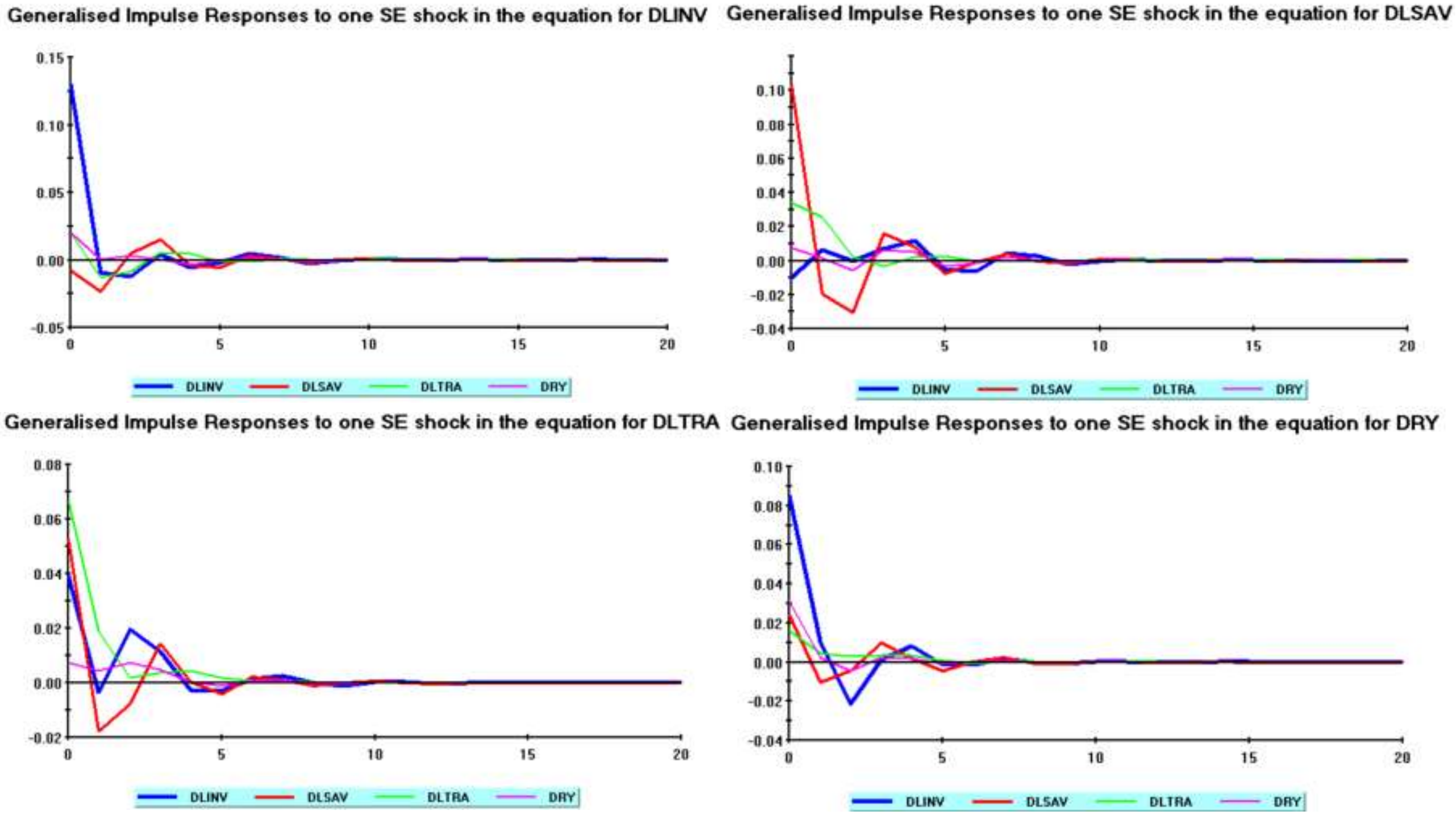

Diagram 2a: Generalized Impulse Response Function for the models with dummy variable D4 and a deterministic trend

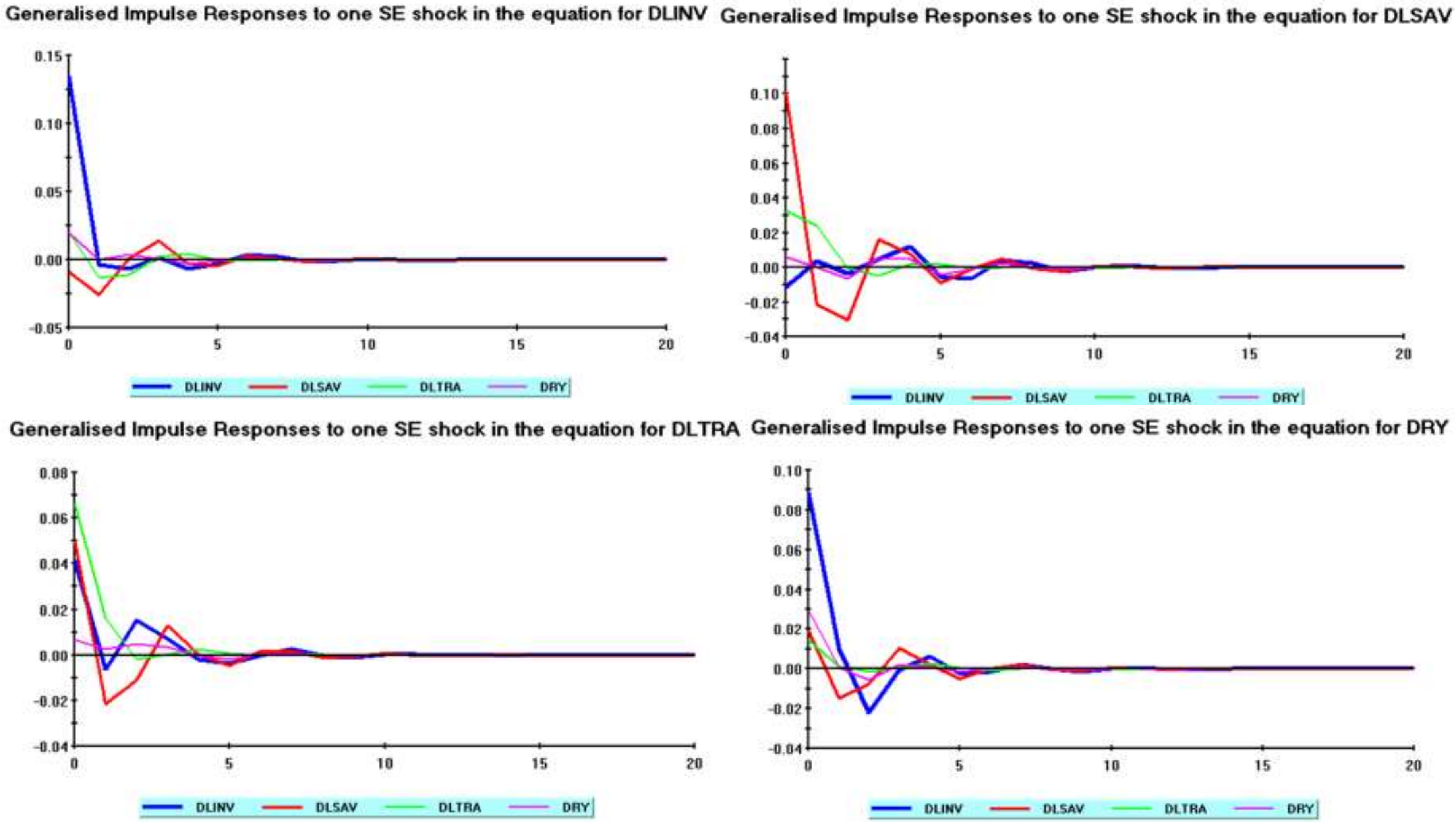

Diagram 2b: Generalized Impulse Response Function for the models with dummy variable D5 but without a deterministic trend

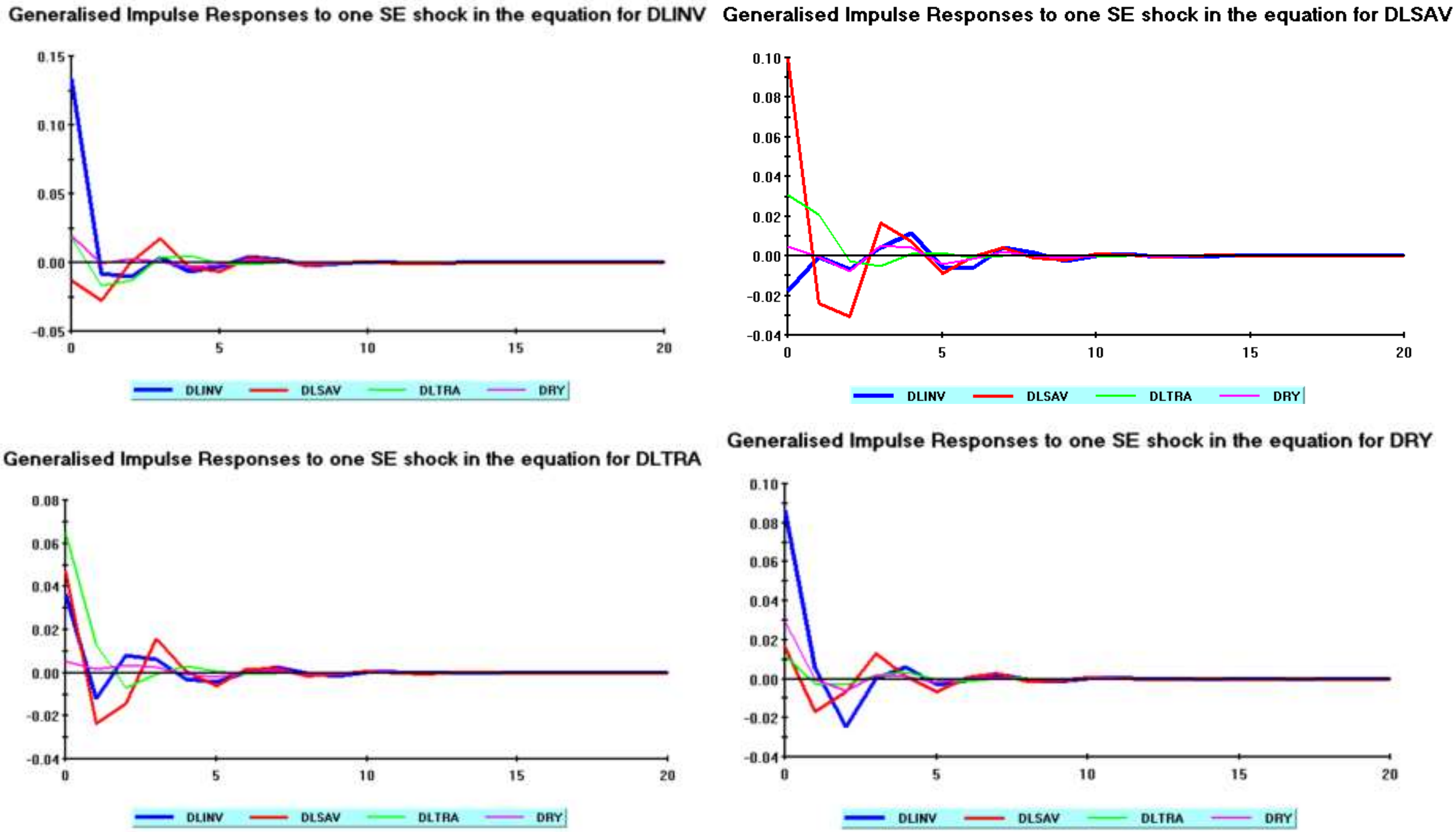

Diagram 2c: Generalized Impulse Response Function for the models with dummy variable D5 and a deterministic trend